Government Support of Research

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IT IS INTERESTING and significant to find government support of research so much under discussion recently. It is interesting because there has been for the past few years a great deal more support from government, and therefore at least the edge of the need has been dulled. It is interesting also because, contrary to the attitude before and immediately after the war, there are few institutions now that are unwilling to entertain the idea of government support. It is significant because we are now in the position, not only of establishing the need for support of research, but also of considering how much support is necessary and prudent and how it should be provided. The value of discussion at the present time lies in the fact that we are now able to evaluate what has been accomplished, at least to some extent, and thus more realistically to consider plans or proposals for the future.

The subject "Government Support of Research" as considered here is limited to support by the federal government to scientific research outside its own establishments. No attempt will be made to discuss support of research by state and city governments, which is a different kind of problem.

It is hardly necessary to review the reasons for government support of research. It may be recalled that before the war there was little or no interest in support of general basic research by the federal government, although there was demand for support in particular areas of research and to some extent for general and higher education. Nevertheless, awareness of need for support had its origin at that time in the concern with which educational and industrial institutions viewed lack of capital, low returns from investments, rising taxes, and hard times generally. But there were few then who advocated federal support.

It is probably salutary to recall that, historically, research has always required a patron; it has never been regarded as self-supporting. We have become so accustomed to the idea of pure research conducted in universities that we tend to forget this fact. Actually, the universities have become the patrons. Research foundations, which operate more frankly in the older tradition, and certain industries have to some extent also assumed this role. If the funds from these sources begin to fail or the demand for research increases it is not surprising to find a search for ways to add to the traditional means of support. As a matter of fact, both conditions have been operative.

This parasitic view of research should not be regarded as humiliating; it puts research in the class with the creative arts, along with literature, music, painting, and sculpture. It may be that the time will come when it is generally realized that pure scientific research does in fact more than pay its way. Certainly a strong case can be made. But we should be careful not to fall into the error of assuming that great discoveries can be bought or that research in certain fields will never be profitable. I doubt whether any such practical justification of pure science will ever come about through the efforts of scientists themselves. There will always be too many among us who regard with apprehension or resentment the motivation of utility. This is probably as it should be, but we must admit that it is a source of misunderstanding when we ask for money.

Much has been said and written of the effect of the war on the need for scientific research. It is true that we drew heavily on our stockpile of scientific knowledge. It is true that most European science, which had long led us in fundamental research, came to a standstill. But other factors were also at work. Academic scientists learned what industry already knew—the advantages of teamwork on scientific problems. Also, notably in nuclear physics and fluid mechanics, large scale and costly installations proved necessary, but beyond the reach of single institutions. We must add to this the urge among many of the scientific fraternity to return to the pursuit of knowledge with a deep sigh of relief after their strenuous years of applied research and development.

It was in this atmosphere that a National Science Foundation was proposed. There are many who feel it a misfortune that the first bill for a National Science Foundation and those subsequently proposed have failed of enactment. However, it is some consolation to realize that we all now know a lot more about the problem than we did, both as a result of the discussion provoked by rival legislation and as a result of experience with such federal support as has been available. This at least is good, and should be helpful in making a National Science Foundation more effective if established.

In the atmosphere just following the war it is not surprising that the military establishment took the

lead in sponsorship of research. Everyone was convinced of the importance of science, and research in particular, to national defense. In 1946 General Eisenhower put forth a strong statement to this effect, and the Navy went into action by securing authorization for a special Office of Naval Research, through farsighted planning led by such men as Robert D. Conrad, Luis de Florez, Harold Bowen, and James Forrestal. It was necessary for the military to act quickly, since their peacetime plans had to be made at once and geared to a much lower level of operation. Besides, many felt that much of the Office of Scientific Research and Development had permanent value and should be retained. In this connection it is interesting to note a statement made in 1885 by the then Secretary of the Navy, William C. Whitney:

> The rapid advance of the art of naval warfare and the singular fertility of human genius in devising new and more formidable implements of destruction are rendering this branch of public service more complicated and difficult. . . .
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> A naval vessel at the present moment is a product of science. Taking the world over it will be found that each part of her—her armor, her armament, her power, and the distribution of her parts or characteristics—each of these features of the completed vessel is absorbing from year to year the exclusive study of a class of scientific men. And as men of science throughout the world are continually stimulated to new discoveries and inventions, no vessel that can be built can be considered a finality in any particular.
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> It is of little service to a nation to have any Navy at all unless it is a fair expression of the highest scientific resources of its day. The destructive power of the modern implements has become so great as to dominate in actual warfare. The bravest and best commander is helpless without them.

Just how broad is the need for support of research? Does industry require or want government support of research? Should *all* colleges aim to do a fair proportion of research? If so, should all receive government support? If not, to which should support go? Should support be given to the institution as a whole, to particular schools or departments, or to qualified or promising individuals? Or should it be on a different basis—support in certain fields of apparent promise or of interest to the donor? Whatever the answer, one has to reckon with the fact of limited government appropriations for the purpose.

And what of the problem of scientific manpower? If we grant the desirability or even the urgency of increased support of research, have we actually an adequate number of scientists and engineers for the job we need to do? It is commonly supposed that we have not, and that no considerable expansion in support of research can be started at once without serious dislocation of existing programs. But this statement is only partly true, and, like all part-truths, can prove a serious obstacle to proper action. It is true that the need for competent scientists in industry and in government is great and that the available supply is low, and the same can be said with even more force with respect to the teaching of science at the more elementary levels. But the operations of the ONR have produced conclusive evidence that there is still abundant room for support of research in colleges and universities, and this may take place with little if any detriment to existing programs for combined research and development. Furthermore, by application of increased support along this avenue we should at the same time take the most direct step toward alleviation of the shortage of highly trained scientific manpower. This research is almost entirely basic in character, and is, consequently, universal in availability to all. Although assistance in this direction could not be counted on to produce immediate practical benefits, the by-products would in many cases lead to important applications. From straight content alone, the outcome would merely add to our store of scientific knowledge. But ideas beget ideas and we should thereby greatly enhance the likelihood of turning up untold treasures, still in the rough.

One may properly ask how it is possible that this situation may exist—an unfilled demand for research scientists and yet an unfilled capacity for accomplishment of research. The answer is evidently that there are many competent scientists who prefer the academic environment and who cannot be induced to leave it. Among them are good research scientists who can, with help of a graduate student or two and funds for equipment and materials, turn out good research without interfering seriously with their present share of educational work.

One consequence of the support now provided is an expressed need by the heads of educational institutions for general funds to restore the balance disturbed by support in special fields.

Questions like these should really be considered by a general agency like the proposed National Science Foundation, or, failing that, by a special commission if the matter is urgent enough. There are other matters, too, which should be more the concern of such an agency than any existing one, such as support of fellowships, underwriting scientific publications, dissemination of scientific information, exchange of scientists, aid to foreign science, and finally, firsthand scientific advice to the executive and the legislative branches of the government.

These are some of the reasons why the ONR should not be regarded as a competitor of the proposed National Science Foundation. For purposes of our pres-

ent discussion, the function of the ONR is to follow and coordinate the research performed by the rest of the Navy and to supplement this by support of research externally and within its two major field laboratories, the Naval Research Laboratory and the Special Devices Center. The ONR interprets this part of its function as justification for backing a limited program of basic research in scientific areas which offer the chance of ultimate important effect upon developments in weapons, devices, and techniques of warfare.

There are other advantages too. As stated by a former chairman, Detlev W. Bronk, of our Naval Research Advisory Committee:

> We feel that there are many important practical needs of the Navy which derive from fundamental research which cannot be immediately identified. We also have faith that there are very important results which are going to issue from research undertakings which cannot, at this present moment, be identified as having outstanding practical value; secondly, we feel that it is of great importance to the Navy that there should be outstanding civilian scientists who are associated with the Navy through their ONR contracts. We feel this is a source of good will, expert advice, and guidance, and one which would not be as available to the Navy if there were not these direct contractual relationships between the Navy and scientists; and finally, we feel that it would be extremely undesirable if all of the support for fundamental research were to be derived from just one agency. This is necessarily a type of support which involves exploration, adventure, and gambling and we think it is sounder, as a basis of operation, if the support be derived from various individuals and various agencies concerned.
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> And furthermore, related to this there will be special needs of different agencies which will be best supported if all of the research support is not derived from just one foundation or one organization.

The ONR research program has been built by selection of research projects proposed by scientists with the endorsement of their institutions. This selection is based upon many factors, such as the scientific value of the research, the capability of the proposing group and their facilities, the degree of support by the institution, both financial and policywise, the probability of ultimate usefulness to the Navy, the relation of the research to that elsewhere in the Department of Defense, and last but not least, the state of the budget. The ONR grants no fellowships, it constructs no buildings for its contractors, nor does it give grants-in-aid. Its means of furnishing support is by nonprofit contracts with the institutions concerned. Much care and thought have been spent on setting up procedures which would leave the investigators free to attack their proposed research in their own way. Supervision by the government, necessary by law, takes the form of close supervision of the program, with the help of consulting panels of experts in each field of research, supervision projectwise over expenditures, and full discussion and decision in the case of change in aim or scope of a project. Almost all this external research with universities is free from security classification. Publication in scientific journals is encouraged, as are conferences and symposia. The ONR reserves the right, however, to discuss immediately any result which requires classification and to obtain agreement to remove the classified portion to some military laboratory or set up adequate safeguards in case the university and the Navy jointly wish to continue the work in the existing location.

Why is federal support of research a problem? There are three standard answers to this question: government support implies government control, it involves administrative red tape and confusion, it is erratic and uncertain. These objections must be met by such safeguards as can be managed in the arrangement set up.

At the risk of oversimplification, let me suggest that for our immediate purpose, federal support of research is a problem for two main reasons, which may be illustrated by two additional questions:

1. Is federal support of research justified? The government requires a satisfactory answer to this.

2. What will be the consequences of extensive federal support? The answer to this is a matter of concern to science, to scientists, and to scientific and educational institutions.

To the former of these two questions the majority of scientists would probably answer that federal support of research is justified provided the values inherent in the traditional environment of research, such as continuity, initiative, and freedom of communication and publication, can be maintained. In other words, most scientists would give an affirmative answer to the former question provided the answers to the latter may be satisfactory.

Let us remind ourselves at this point that Uncle Sam is properly a realist. He may believe in charitable donations for some of the people all the time, for all the people some of the time, but not for all the people all the time. In general he expects to pay only for services rendered. Thus the federal government does not provide financial support unless a need can be established, and when such support is provided it must be expected to show some return to the taxpayer.

As a quick answer to our first question, then, intelligent support of research should be able to accomplish the following:

1. Raise the productive level of research, with the many attendant benefits sure to follow;

2. Increase the output of young research men and women and thus fill the needs of industry, government, and academic institutions.

But let me turn at once to my second question: What may we expect to be the consequences of extensive federal support of research? As mentioned earlier, I shall consider only the case of support in institutions external to the government, and especially in nonprofit institutions such as universities, technical institutions, and colleges. I shall confine my remarks to support given on broad, comprehensive lines, and so not mention the support furnished by agencies with special fields in view—as for example the excellent work done by such agencies as the Public Health Service and the Department of Agriculture.

In the first place, if we are to be realistic we must at once admit that extensive government support of research will have consequences beyond the important and beneficial ones of stimulating research output and supply of future scientists. It is a commonly observed fact that any attempt to change some factor in a situation is accompanied by effects other than those intended. Indeed experimental science knows that it is only by careful planning and painstaking attention to techniques that these spurious effects may be kept in the background.

For one thing, increased support of research in universities has been accompanied by an increased number of graduate students. What effect will this have upon the quality of the doctor's or graduate engineer's degree? It may be that by increasing graduate school enrollments we shall succeed in turning out no larger number of potential research leaders but shall actually lower the average competence of the total output, by dilution and by congestion. Perhaps increased demand for trained research men and women and for research administrators may to some extent justify such a tendency, but the situation should be watched.

Research institutions generally are apprehensive of possible dictation or control over their research by a supporting agency. The independence of an institution is threatened if pressure can be applied toward the acceptance of undesired work. This may be minimized by the policy of basing support on proposals initiated from the institution, by the avoidance of permanent construction owned by the supporting agency, and by a cooperative program of joint support. For a given institution, any danger of control may be balanced to some extent by internal adjustment and by the existence of a number of sources of support. Objectionable control with respect to progress on individual problems can certainly be avoided by intelligent management. Nevertheless, even though no pressure is intended, it is undeniably true that the mere selection of research for support by an outside agency is itself a form of control.

A subtle form of this influence may be expected to manifest itself in varying degrees by the tendency of an existing research group to perpetuate support from the same source, and the attempt of other groups to slant their program in the direction of probable areas of support. This tendency should be recognized and any instances identified both by the institution and by the supporting agency.

A prospect may exist, especially among universities, which is of more fundamental concern to the cause of basic research. As already mentioned, the government quite properly invests its money in areas which will bring a return to the taxpayer—that is, in activities which promote the national welfare or security. This implies an emphasis upon short-term tangible and practical results, and this is foreign to the nature of pure or basic research. Will we therefore see in government support a verification of the truth first pointed out by Vannevar Bush in "Science—The Endless Frontier," that applied research tends to drive out basic? This would indeed be tragic. All the elements that go to make up our high standard of living, in fact a very large part of the world's thought and progress, have come about through pure or basic research in the broad sense, that is, creative work in the arts and sciences. The great discoveries cannot in general be predicted nor can they be made to order. There is no need to give examples—history is eloquent on this score. This is admittedly a troublesome point. I believe it must be met by an insistence upon support of basic research in its own right. If a practical justification is required, let us call it a necessary investment for the future. It will be dangerous for basic research to compete for funds with applied research and development, which can cite probable practical accomplishments. This difficulty might be handled in the federal budget by general agreement that every agency should have a limited sum or a limited fraction of its budget set aside for research, and that this sum should not require detailed budget defense in advance. Instead, the results of the research program should be subject to periodic review.

A quite different consequence of support of research by contract follows from the amount of administrative detail required of the institution and the supporting agency. Many academic institutions, not accustomed to this degree of administrative detail, have found it advisable to set up a special office and staff for research administration, particularly where there is a considerable volume of industry- and government-supported research. This is of course an advantage in that it takes many administrative details off the shoulders of the chief investigators and the scientific

departments concerned. It is obviously important to centralize this function within the institution. The growth and strengthening of these administrative offices is a consequence of support by contract. However, there is an aspect of this development which may bear watching, namely, the possible tendency of a strong administrative office to dominate the research program of the institution. In fact, an aggressive office is in position to exercise pressure upon the research staff of the institution itself. Or it may tend to insulate the scientist from his opposite number in the supporting agency.

Another movement, which may be related to the one just mentioned, is the establishment or the strengthening of research institutes or foundations, attached to a university but separated to a greater or less degree from the academic or educational plant. Such organizational units have advantages from the standpoint of handling externally supported contracts and of increasing the research business of the institutions. They can accept support for applied research or development with less fear of upsetting the balance between education, basic research, and applied research. They can more readily go in for group research and more extensive programs. To some extent they can protect the university from sudden fluctuations in financial support. They can more readily accommodate confidential work, either from industry or government. But such a unit may run into rather troublesome situations, such as a salary differential between its staff and faculty members not connected with it. For another thing, if it goes in strongly for applied research and development and is ready to accept projects upon request, it may come into competition with commercial research agencies. This competition may be regarded as unfair if the unit takes advantage of its nonprofit and tax-exempt status to quote lower costs for research or development undertaken. It is of course early to say, but it is possible that, unless great care is exercised, the advantages gained by this separation of research from education may be offset by deterioration in fundamental research.

These are some of the consequences which may be anticipated from government support of research. They are of course bound up with the mission of the sponsoring agency and also the policy and procedures established by this agency. These are to a certain extent dictated by governmental limitations, both as to allowable procedures and as to mission. In this connection, I should like to return to a point mentioned earlier, namely, the importance of a government agency's having the authority and opportunity to pursue basic research. Let me illustrate by the case of the ONR as a typical example. This office has as its aim the sponsorship of research for the Navy Department. Since the Navy's mission is national defense, it is clear that the money spent by the department should be directly related to national security. Insofar as national security implies scientific strength in the country as a whole there is justification for wide support of science, provided the country's science is felt to require assistance. This was admittedly the case immediately following the war. The question then arises whether the department should continue to give widespread support to science if and when a stage shall have been reached of a strong, stable scientific effort in the nation. It is the considered judgment of the ONR—and this is fully endorsed by its Naval Research Advisory Committee—that the Department of the Navy is still justified in continuing support of basic research in outside institutions, provided the level of this operation is definitely limited and is appropriate to Navy needs. The reasons for the interest of the ONR in basic research may be expressed as follows: The Navy's interest lies in end results, whether weapons, devices, or techniques; very many of such end items have their origin in science. Now, progress toward these end items occurs in the following sequence: basic research, applied research, development, test, and production. Note that this chain of events begins with basic research. This beginning may be found in scientific literature or in current research.

One of the most promising avenues toward accomplishment, then, is to expedite this sequence. Sometimes progress may be held up for lack of basic research; again there is apt to be serious delay between the basic research stage and that of applied research, or between the development and production. The ONR conceives as one of its most important functions the speeding up of the research end of this sequence. Any progress along this road can be an untold asset for national security. It should be clear that real effectiveness in such a mission can be accomplished only when the agency concerned has responsibility for support of basic research, for quickly seeing promising applications and for assistance in initiating appropriate action within its department. In the long run this job cannot be handled adequately if left entirely to some other agency. This was a mistake made by the military establishment prior to World War II. It is certainly true that a second-hand method of providing this service is also second-best, and this is hardly justifiable when we are dealing with national security. The case is, in fact, quite similar to that of the technical industries, which have long recognized the necessity of supporting research.

It should not be forgotten that there are areas in basic research which are of the greatest importance

to a particular agency such as the Department of Defense or the Department of Commerce, but where no general research agency like a National Science Foundation would be expected to provide adequate support. In these areas the government department can hardly expect adequate and timely support from a foundation where the work has to compete with the latter's own mission and with outside requests. Furthermore, at any given time specific areas in basic research can be identified as bottlenecks to existing developmental programs. Again the operating agency critically needs authority to pursue these on its own initiative. Quite apart from these considerations, it is my personal belief that no one should question the right of an operating agency to place a limited fraction of its support in extremely pure or fundamental research in the major fields of science. This appears to me completely justifiable in many ways. For example, there is the opportunity of uncovering a radically new discovery of significance chiefly to the agency, ties are thus established by the agency with up-to-date scientific thinking, barriers between science in government and outside science are destroyed, the morale of scientists at work for the agency is improved, and competition in pure research serves as a stimulus. Finally, I believe it is the opinion of most scientists that research should never become the monopoly of any agency, government or otherwise.

I have remarked earlier that the government expects practical results from the support of research, and that in basic research the investigator should be as free as possible to work out his ideas. These ideas usually have nothing to do with possible application, and in fact any practical consequences are generally regarded as irrelevant to the investigation. How are we to reconcile these apparently opposing points of view? The answer is clear. In general, we must consider the practical application of ideas from basic research to be the responsibility of the supporting agency and not that of the investigator. This recognizes a well-known fact that many research men have no particular aptitude for applied research or, if they have, do not make use of this aptitude except in solving their own research problems. Thus a research investigator may show a high degree of ingenuity in devising a piece of his apparatus to perform a special, practical function, but he regards this ability as important only to the accomplishment of his main purpose, the solution of his problem. If his attention to his chosen goal is deflected the probability of his making a creative contribution is considerably reduced. It is the integrated total of such accomplishments that form the backbone of true scientific progress.

On the other hand, the supporting agency should choose its staff to include scientists of a more practical turn of mind who by association with the needs of the agency are in the best possible position to spot possible applications and to carry them forward in the hands of the proper group in their department. If this policy is followed, there should be minimum difficulty in insuring proper environment for the sponsored research and, at the same time, satisfactory output of practical suggestions. What is more, the tendency toward improper pressure on the research worker or his institution is eased thereby.

In order to arrive at adequate safeguards to insure reasonably effective operation of external research programs supported by a government agency, it may be profitable, at least for purposes of discussion, to attempt to lay down a few guiding principles. I propose the following:

1. In selection of items for support, emphasis should be placed upon the field of interest of the agency and upon the caliber of the investigator, with final selection made from specific problems proposed by interested research scientists and accompanied by endorsement of their institutions.

2. Every effort should be made to insure that the working conditions are appropriate to research. These mean freedom in performance of research and freedom to publish and to exchange information with colleagues.

3. Administrative details should be handled as fully as possible by the respective administrative staffs of the institution and the supporting agency. However, the initial arrangements and any subsequent changes should be reviewed by the interested scientists on both sides.

4. The supporting agency should possess a scientific staff with full authority regarding approval of research projects and it should have committees of experts to guide it in formulation of its program.

5. The scientific staff of the supporting agency should be composed of scientists with research experience who know from personal background the conditions that should be maintained. This staff should be competent to discuss the work intelligently and intimately with the working research groups. It should also be competent administratively and organization-wise to deal effectively with administrative and service units in the agency and also with other agencies with which the work should be coordinated.

While the success of any plan for government support of research obviously depends on the administration of the supporting agency, it must at all times be remembered that no charter, no administrative setup, and no staff can succeed in this relatively unchartered area without full cooperation from the institutions supported. It is impossible to solve many questions on a unilateral basis. A common misap-

prehension is that administrative questions arising in a research program may be solved apart from scientific matters or vice versa. In point of fact, the two are apt to be inextricably mingled. In the negotiation and administration of supported research there are and should be four groups involved: the research group at the institution, the scientific staff of the agency, and the administrative offices of both the institution and the agency. It is also desirable that the policy of the supporting agency be flexible enough to adjust to the policy of the institution, within limits. Above all, I wish to emphasize the great importance of a cooperative interest on the part of the research investigators in the program supported by the government agency. This cooperation should be kept extremely close, in order that the agency may meet or even anticipate the needs of the research group, and in order that it may plan effectively. A successfully organized program should have the weight of approval of all its constituents. If this is achieved, government support of research will be abundantly justified.

Technical Papers

Fluorometric Determination of Serum Aureomycin Levels

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In view of the difficulties associated with the bacteriologic assay of serum aureomycin concentrations, a method was developed of determining these concentrations by adsorbing the aureomycin on small columns of silica gel and observing the yellow fluorescence at the top of the column. A fluorometric method of measuring high concentrations of aureomycin has been reported by Kelsey and Goldman (*1*), but their procedure is not applicable to determining the low concentrations found in clinical material.

It was observed that aureomycin had an intense yellow fluorescence in an acid or neutral medium and that after several minutes in an alkaline medium it began to be altered to a compound with a blue fluorescence. Inasmuch as yellow fluorescing compounds are a great deal more uncommon in body fluids and among medications than blue fluorescing compounds, it was felt that a test depending on yellow fluorescence would be less subject to interference than one depending on blue fluorescence. Hence, only neutral solutions were used.

Two-hundred-mesh activated silica gel (Davison) was backwashed with distilled water at 100 ml/min on a column 50 mm × 1 m for 3 hr. This removed the very small particles and gave a suspension of particles of fairly uniform size. To a 20-cm length of 6-mm glass tubing constricted at one end and packed with glass wool, there was added, by means of a capillary pipette, enough of a slurry of the prepared silica gel to form a packed column 3 cm long. Packing was achieved by repeated tapping of the column until no further settling occurred. One ml of serum containing aureomycin was allowed to filter through the silica gel column without vacuum or pressure being applied. The serum was followed by 1 ml of isotonic saline and 1 ml of 95 or 100% ethyl alcohol. The saline served to wash out the serum, and the alcohol intensified the fluorescence. At no time was the surface of the silica gel column allowed to dry out or be mechanically disturbed by the addition of fluids. Standards were prepared, in the same manner, with sera to which 20, 10, 5, 3, 2, 1, 0.5, 0.2, and 0.1 μg of aureomycin hydrochloride[2] had been added. The aureomycin was diluted to the appropriate concentration in distilled water and 0.1 ml of the dilution added to 0.9 ml of serum. The unknowns were visually compared to the standards, after dark adaptation, in a darkened room with the focused light from an 85-watt argon-mercury lamp filtered to remove all wavelengths above 400 mμ. The fluorescence appeared at the top of the column as a yellow band, which varied in width and intensity according to the concentration of aureomycin. Standards must be prepared every day or two, since the fluorescent color tends to fade. The success of this procedure depends in large measure on obtaining uniform silica gel particles and in uniformly packing these particles into a column free of bubbles.

The procedure may be modified to determine aureomycin in urine, spinal fluid, and other media. These modifications and the preparation of permanent standards will be reported elsewhere.

The fluorometric test was checked against bacteriologically determined levels on two healthy subjects who took, respectively, 9.3 and 10.4 mg/kg of aureomycin orally, and on patients who had received a single intravenous dose of aureomycin. The results are recorded in Table 1.

A test for interfering substances was made by adding aureomycin to the sera[3] of patients receiving other medi-

[1] The authors wish to thank Dr. Eleanor Bliss, of The Johns Hopkins Medical School, for her stimulating suggestions and encouragement.

[2] The aureomycin hydrochloride used in these experiments was supplied by the Lederle Laboratories Division of American Cyanamid Company, through the Antibiotics Study Section of the National Institutes of Health.

[3] These sera were obtained through the kind cooperation of the members of the House Staff of The Johns Hopkins Hospital.

cations. Patients with jaundice, cirrhosis of the liver, leukemia, arteriosclerosis, rheumatic fever, acute pneumonia, and other conditions were included in this test.

TABLE 1

A Comparison of Fluorometric and Bacteriologic Methods of Determining Serum Aureomycin Concentrations

Patient	Aureomycin dosage	Time after administering dosage	Fluorometric levels μg/ml	Bacteriologic levels μg/ml
C. W.	9.3 mg/kg orally	Control*	0	0
		1 hr	1	0
		2 hr	4	2.5
		4 hr	5	2.5
		6 hr	4	1.25
		8 hr	3	1.25
		12 hr	1	0.3
		24 hr	0.2	0
J. W.	10.4 mg/kg orally	Control*	0	0
		1 hr	1.3	0
		2 hr	1.7	0
		4 hr	3	2.5
		6 hr	2	1.25
		8 hr	3	1.25
		24 hr	0.5	0
W.	200 mg I. V.	Control*	0	0†
		75 min	3	2†
R.	200 mg I. V.	Control	0	0†
		30 min	2	0.5†
B. W.	? I. V.	75 min	1	1†
B. R.	?	30 min	1	0.5†
M. W.	200 mg I. V.	Control*	0	0†
		5 min	15	10†
		15 min	3	1.25†
		30 min	3	1†
		60 min	2.5	1†

* Control tests were performed on patient's sera before aureomycin dosage.

† These bacteriological levels were performed by Dr. Caroline A. Chandler of The Johns Hopkins Medical School.

They had received a variety of medications including sulfa drugs, penicillin, dicumarol, salicylates, and vitamins. In addition, streptomycin and chloramphenicol were each added to a serum containing aureomycin. In no case was anything found which interfered with the fluorometric test.

In the few determinations reported, there is a general correlation between the fluorometric and bacteriological assays. The fluorometric test appears to give slightly higher readings than the bacteriologic test. This suggests that the fluorometric test is measuring not only aureomycin but, in addition, something which is closely allied to and associated with aureomycin and which is bacteriologically inactive. Efforts are being made to define further the accuracy of the fluorometric test.

Reference

1. Kelsey, H. A. and Goldman, L. *J. clin. Invest.*, 1949, **28**, 1048.

Preparation of C^{14} Uniformly Labeled Fructose by Means of Photosynthesis and Paper Chromatography[1]

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The common carbohydrates, glucose, fructose, sucrose, and starch have been labeled with C^{14} by allowing leaves to photosynthesize in the presence of $C^{14}O_2$. However, only glucose, sucrose, and starch have been prepared with sufficient purity and activity to permit their use in tracer experiments. Fructose has not been available for tracer work because of the difficulty in separating it from glucose following sucrose hydrolysis. Putman *et al.* (*5*) used the calcium-fructose complex methods as described by Bates and associates (*1*). This method has two disadvantages: large amounts of carrier fructose are added, yielding a product of very low specific activity; and the fructose still contains appreciable amounts of glucose.

Recently Partridge (*4*) applied paper chromatography to the qualitative analysis of reducing sugars. The separation of glucose from fructose on a one-dimensional chromatogram using phenol as the solvent is very good (R_f glucose – 0.39, R_f fructose – 0.51). A 1-in. strip of paper can be used to separate as much as 0.3 mg of fructose from a similar amount of glucose. By using several strips of paper, we have prepared in very pure form milligram amounts of highly active fructose.

After four trifoliate bean leaves had been allowed to photosynthesize in the presence of 2.8 mc of $C^{14}O_2$ (*3*), they were killed in hot 80% alcohol. This alcohol extract contains sucrose, glucose, and fructose as well as other alcohol-soluble substances. After ether extraction and passage through ion exchange columns (Amberlite 100-H and Duolite A-4) to remove polar compounds, H_2SO_4 was added to make the solution 1 *N* and it was kept at 80° C for 10 min. After hydrolysis, the sample was again passed through the ion exchange columns to remove the acid. Most of the glucose was crystallized from the mixture by the addition of carrier glucose followed by the addition of alcohol.

To separate the fructose from the glucose still remaining in the mother liquor, 75 chromatograms (14 × 1.5-in. strips of Whatman No. 1 filter paper) were set up with 0.1–0.3 mg of sugar per strip. After development with phenol, the strips were air-dried and placed on x-ray plates (Eastman Type K). It is evident from Fig. 1 that a radioautograph of each strip is necessary, since the bands are not always in the same position. In about 2 hr the radioautographs were dark enough to permit tracing of the outlines of the bands onto the chromatograms. The outlined fructose bands were cut out and pooled, giving a total of about 2 g of filter paper. About

[1] Research carried out at Brookhaven National Laboratory under the auspices of the Atomic Energy Commission.

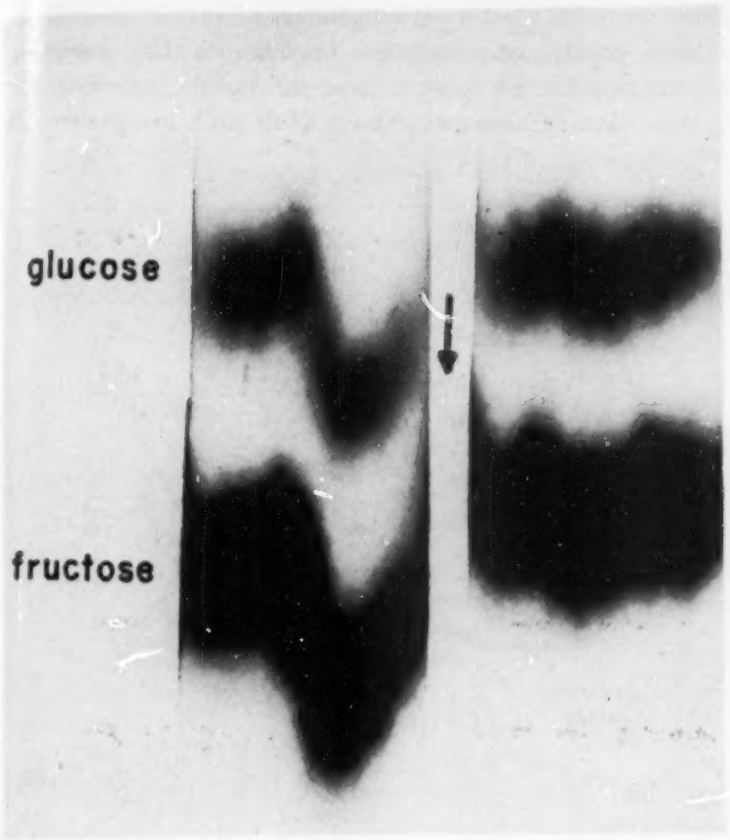

FIG. 1. Radioautograph of chromatogram of glucose and fructose.

10 mg of fructose was eluted from the paper by boiling the paper with 80% alcohol, followed by Soxhlet extraction for 5 hr. The alcohol was removed by vacuum distillation, water being added from time to time. The aqueous solution was extracted with ether to remove traces of phenol. To remove other impurities, the solution was passed through ion exchange columns (Amberlite 100-H and Duolite A-4) with 30 mg of carrier fructose added. The resultant solution (about 300 ml) was concentrated at 35° C to a small volume and finally concentrated to a syrup in a vacuum oven at 35° C.

The syrup was crystallized as described by Putman *et al.* (*5*). Thirty mg of fructose was added during the crystallization. Since the amount of fructose was small, it was found convenient to carry out the crystallization steps in a centrifuge tube and to collect the fructose by centrifuging in a refrigerated centrifuge. The purity of the fructose was determined by paper chromatography, using as solvent butanol and water saturated with propionic acid (*2*). Only one band was found. The final product had a specific activity of 1.2 mc/mg of fructose. A portion of the fructose was degraded by the microbiological method of Wood, Lifson, and Lorber (*6*) and found to be uniformly labeled.

Many groups of compounds other than sugars—for example, amino acids, peptides, and carboxylic acids—can be subjected to chromatography on paper in milligram quantities. This large capacity and the simplicity of the technique make paper chromatography valuable for the isolation of such compounds as well as for their assay.

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A Megalonyx Tooth from the Northwest Territories, Canada

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Among a miscellaneous collection of fossils submitted by Galen B. Smith to the junior author for identification, there was one specimen which deserves special attention. It was a tooth of a ground sloth, and according to Mr. Smith was obtained at Lower Carp Lake, north of Great Slave Lake in the Yellowknife region.[1] It was associated with fragments of a mastodon tooth. The specimen was sent to the senior author for detailed study.

The tooth (No. 15208, Academy of Natural Sciences, Philadelphia—Fig. 1a,b), is like the second lower cheek tooth of *Megalonyx* in shape and straightness of crown. It also resembles in cross section the second upper cheek tooth in this genus. While the wearing surface of the

FIG. 1. *Megalonyx* cf. *jeffersonii* (Desmarest). Lower cheek tooth, No. 15208 Academy of Natural Sciences, Philadelphia. (a) Occlusal view; (b) anterior (?) view. Natural size. Pleistocene, Yellowknife region, Northwest Territory, Canada.

tooth is somewhat abraded, the features which result directly from its occlusion with opposing teeth can be ob-

[1] 63° 35′ N; 114° 10′ W. See Rae sheet (85 NW-NE) National Topographic Series of Canada.

served, and these are similar to the characters noted in the second lower cheek tooth. The specimen resembles, but may be slightly smaller than, the comparable tooth of *Megalonyx jeffersonii*. Dimensions, in mm, of the Academy of Natural Science's No. 15208 are: transverse diam 25.9; anteroposterior diam 17.7.

Interest in the specimen arises largely from its occurrence so far north on the American continent. In 1942, Stock (*2*) reported the occurrence of a ground sloth at a locality 15 miles southwest of Fairbanks, Alaska. This identification was based on a phalanx, representing apparently a species of *Megalonyx*. The tooth from north of Great Slave Lake is the second occurrence of the ground sloth *Megalonyx* to be noted in the northwestern region of North America, but the locality is considerably east of Fairbanks, Alaska.

The Yellowknife specimen is undoubtedly of Pleistocene Age, although its exact position within the Pleistocene is uncertain. It is perhaps not surprising to find the genus ranging this far north during Pleistocene time, in view of its usual association with forest faunas. The Yellowknife and Fairbanks specimens are the only two records of a ground sloth north of the United States-Canadian boundary. These specimens may date from the warm phase of postglacial time, or they may be older and date from an interglacial stage. An interglacial age of some of the Quaternary mammals from Alaska has been suggested by Johnston (*1*).

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Infrared Spectrometry of Small Samples with the Reflecting Microscope

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It has been shown (*1*) that the usefulness of infrared spectrometry may be extended through the application of the Burch (*2*) reflecting microscope. As this microscope is a custom-built instrument available only at Oxford, we investigated the possibility of using American reflecting microscopes in connection with infrared spectrometry.

The Bausch and Lomb Optical Company's Grey design Type V apochromatic reflecting microscope condenser and objective of 0.72 NA (*3*) were placed at our disposal, through the courtesy of Mr. L. V. Foster of that company, for tests in the infrared region of the spectrum. From the standpoint of infrared spectrometry these units are not as useful as totally reflecting systems because of their limited frequency range (from the ultraviolet to 2500 cm^{-1}) imposed by the inclusion of refractive and infrared absorptive elements. It was possible, however, to obtain infrared spectra from the visible region to the carbon dioxide absorption near 2400 cm^{-1}, using samples of microscopic size.

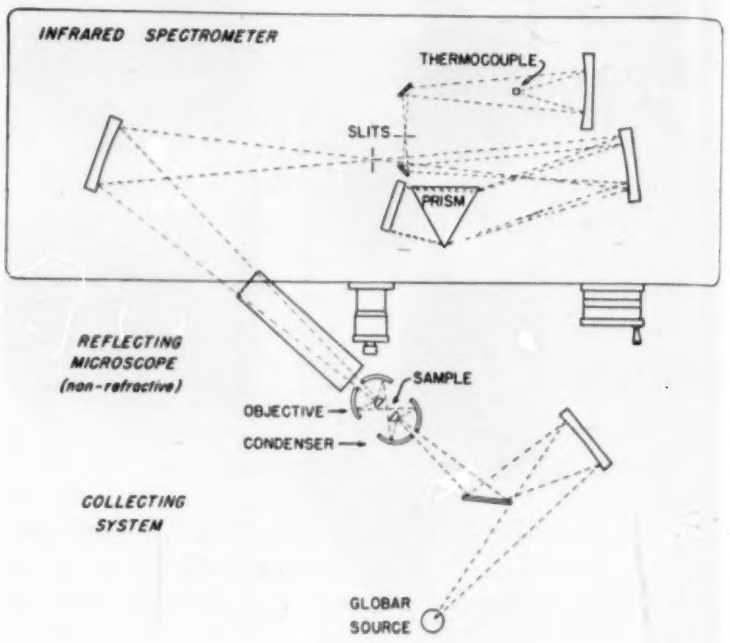

FIG. 1.

The promise shown by this study made it desirable to investigate the utility of the Bausch and Lomb Grey design, Type IV, 0.4 NA condenser and objectives (*3*). This design includes only reflecting elements. One model existed at the time of this investigation, and it was owned and operated by the Polaroid Corporation; its loan was made possible through the great courtesy of Dr. E. R. Blout of the Research Laboratories of that company and Prof. E. G. Rochow of Harvard, who kindly and carefully transported the microscope to and from Stamford.

It was not possible to introduce obvious optical refinements into the system because of the shortness of the time of trial, so the microscope was added to the optical system of a Perkin-Elmer model 12B infrared spectrometer, as shown in Fig. 1. An auxiliary Globar source collected the radiation and focused it into the reflecting condensing system. The focused radiation, after passage through the sample, was collected by the objective. The condenser and objective were mounted on a standard microscope which had been turned on its back. Any microscope equipped with a swinging stand for horizontal photography, or the Bausch and Lomb Type DDE, could be used (if the large reflecting optics would fit). The radiation emerging from the draw tube, without the use of an ocular system, was collected by the first spheroidal mirror of the spectrometer. This mirror then focused the enlarged image of the specimen onto the entrance slit. The physical dimensions were adjusted so that the diameter of this image was equal to the length of the slit.

The portion of the image of the specimen subtended by the entrance slit could be controlled by adjustment of the specimen on the mechanical stage of the microscope. The sample could be suspended in mineral oil on a rock salt plate or between plates, according to the customary infrared technique, placed in solution, or attached to a

[1] The author wishes to acknowledge the interest and help of Dr. T. G. Rochow and Mr. E. J. Thomas of the Microscopical Department of the Stamford Research Laboratories.

stretched fine wire by lightly greasing the wire with mineral oil. From the weight of a crystal suspended on the wire, the area of the specimen image on the slit,

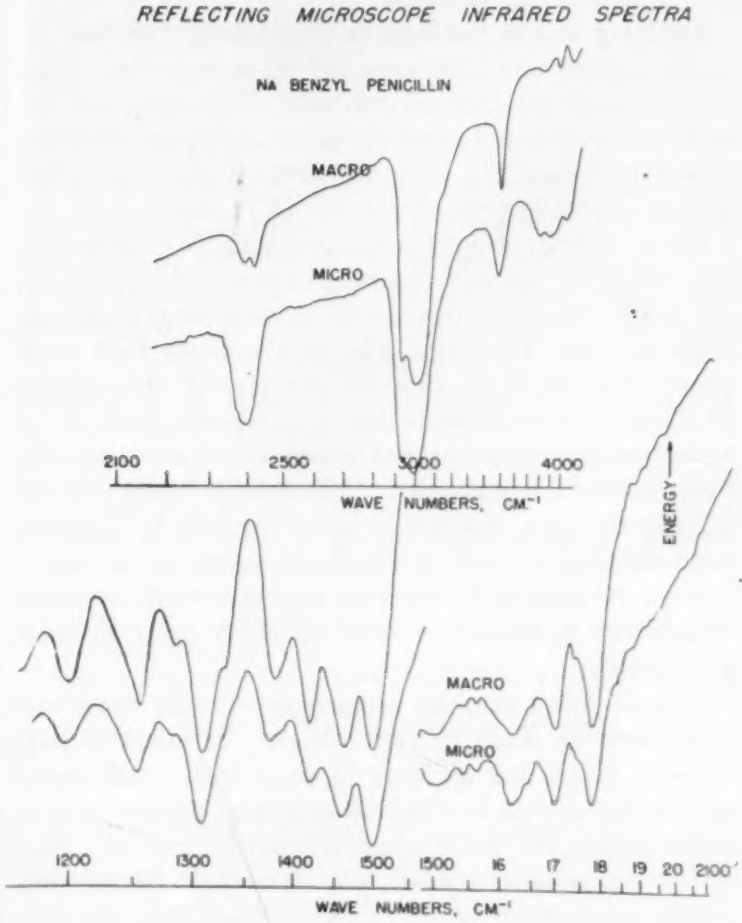

FIG. 2.

and the area of the slit it was possible to estimate the mass of the sample under observation. Inasmuch as the slit width must be increased as the wavelength is increased because of the black-body characteristics of the radiation source, the estimated mass of an observed sample varied from 0.3 μg at 4,000 cm^{-1} to 3 μg at 650 cm^{-1}.

A portion of the spectrometer recordings on macro and micro size samples of sodium benzyl penicillin are shown in Fig. 2. The effect on resolution of the wider-than-usual slit widths necessary with the microscope is observable near 2400 and 1325 cm^{-1}. The micro sample recording was made with an amplification of the thermocouple output such that 0.3 μv gave a full-scale deflection of the Brown recorder. More careful adjustment of the optical system should enable the use of smaller slit widths and less amplification.

It is obvious that the use of such totally reflecting microscope systems in connection with infrared spectrometers should permit large reductions in sample size with attendant increased applications in the biological and crystal structure fields.

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A Method for the Study of Blood Loss in Hookworm Infestation[1]

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Leichtenstern (*7*) pointed out in 1886 that the hookworm (*Ancylostoma duodenale*) was an avid consumer of blood. In 1909 Whipple (*9*) made the same observation in this species as well as in *Necator americanus.* In 1931 Wells (*8*) reported a series of observations involving *Ancylostoma caninum* while the parasites were attached to the intestinal mucosa of living dogs indicating, without a doubt, that this parasite was able to withdraw enough blood per day to account for the anemia often found associated with hookworm infestation. Work done by Cruz in Brazil, and by Rhoads and Castle and their associates in Puerto Rico has materially contributed to our knowledge of this parasitic disease. Wells (*8*) states that there is a possibility that a single worm may withdraw as much as 0.8 ml of blood in 24 hr but that there is apparently a considerable amount of variation in the activity of individual worms.

We present here a pair of preliminary studies of the average rate of blood loss in moderately infested dogs. These studies were carried out in order to determine the feasibility of the method of approach used, with the intention of extending it to a study of human hookworm infestation at a later date.

Two healthy adult mongrel dogs, 2-G and 1-J, were used in these studies. They had both been kept at an anemic level of blood hemoglobin for many months by frequent controlled hemorrhages and their reserve stores of iron were therefore depleted. At the time of application of the larvae the dogs' red cell hematocrits were 24% and 25%, respectively. About 2,000 infective larvae of *Ancylostoma caninum* suspended in saline were applied to each animal, contact being made between the toes and on the groin, where the body hair was sparse. The animals were fed a diet consisting of white bread, Klim, salmon, and cod liver oil in order to restrict iron intake (*6*), and were housed in cages with perforated metal floors. After a period of 5–6 weeks several examinations of feces showed numerous ova of the parasite. One of the dogs, 1-J, earlier had severe diarrhea, accompanied by the excretion of a moderate amount of mucus and red blood.

Four weeks following application of the larvae each animal received by vein 100 ml of blood from a donor dog. This latter animal had previously been fed large quantities of radioactive iron while anemic in order to build up red cells containing tagged iron in the hemoglobin iron (*5*). Immediately after, the diet was again allowed to consist of hospital table scraps so there was no exogenous deficiency of iron.

[1] This work was supported by a grant from the Nutrition Foundation.

Blood was collected in isotonic sodium oxalate and centrifuged at about 2,800 rpm in a type 2 International centrifuge for 35 min. The plasma was decanted and discarded. The red cells were wet ashed and their contained iron was separated by precipitation, electroplated, and examined for radioactivity content (*2*). Correction was made for decay of the isotope and for removal of the tagged iron by blood sampling as described elsewhere (*4*).

When administered by mouth to an anemic iron-depleted dog, the radioactive isotope of iron will in part be absorbed and this fraction will be incorporated for the most part in the red blood cell hemoglobin, very little being stored in other tissues. The level of the tagged iron in the red cells remains quite constant over many months, provided there is no loss by bleeding (*4*). If there is destruction of cells due to aging or hemolysis, the liberated iron is promptly reutilized to form new hemoglobin with the restoration of the original level of isotope in the circulating red cells (*4*). When the red cell isotope levels of the two dogs infested with hookworm were plotted they showed a regular drop, which appeared to be logarithmic. Plotted on semilogarithmic paper, this was borne out in the case of Dog 1-J. However, with Dog 2-G there seemed to be two periods in which the rate of blood loss was somewhat different.

In order to determine the rate of blood loss from the curves we may set up the following relations. For the sake of simplicity we shall consider only the part of the isotope curve which corresponds to the period where the hematocrit level was reasonably constant. It has been pointed out that under conditions allowing sufficient time for establishment of equilibrium in the circulation, the red cell mass is approximately a linear function of the jugular hematocrit (*3*). During the time in which there was no marked change in the hematocrit level, there was a nearly constant red cell mass in the circulation. Thus the rate of regeneration of red cells approximately equaled the rate at which they were lost to the circulation by the blood-sucking activities of the *Ancylostoma*. This may be expressed:

$$dv \longrightarrow \frac{N}{V} \longrightarrow dv$$

where v is the increment of red cell mass regenerated or lost in *ml*, N is the amount of radioactivity expressed in cpm, and V is the mass of red cells in the animal's circulation. Then

$$dN = N/V \cdot dv$$

Transposing and integrating between proper limits:

$$\int_{N_o}^{N} dN/N = 1/V \qquad \int_{O}^{v} dv$$

or $1n \frac{N}{N_o} = \frac{v}{V}$ (provided there is perfect mixing, which we are justified in assuming because of the time relations involved in the experiment). Since the concentration of radioactivity in the red cells is shown by

$$C = N/V \text{ and } C_o = N_o/V:$$

then $v = V\ 1n\ N/N_o = V\ 1n\ \frac{C}{C_o}$

or $\frac{N}{N_o} = C\ \frac{-v}{V}$.

If we take $v = V$, then $N/N_o = 1/e = 0.37$, i.e., if outflow equals the original red cell mass, the isotope concentration is 37% of its original value.

Applying this to the data on Dog 1-J we find that the initial activity was 2,000 cpm/100 ml of red cells. Then $0.37 \times N = 740$ cpm/100 ml red cells. This value for isotope level was found after 27 days. Applying the same procedure to Dog 2-G, we find the red cell mass equivalent to that originally present was lost in 16 days.

Based on body weight and hematocrits (*5*), these dogs had estimated red cell masses of 250 ml (2-G) and 275 ml (1-J). Roughly, this would indicate total blood volumes of about 1 l each. The data indicate that it required only 16 to 27 days for the loss of this amount of blood in these animals due to the proclivities of the hookworm, the animals at the same time maintaining relatively constant hematocrits. This rate of blood loss and regeneration is compatible in each case with the approximate amounts of blood it was found necessary to remove from these animals in order to maintain fairly constant hematocrits in similar periods of study prior to these experiments.

Loss of blood through hemorrhage by any route also lends itself to study by this method. It would perhaps be more direct and accurate to measure the radioactive iron in the excreta in this and any other similar type of investigation, but this is sometimes not convenient. Such direct measurements would not be subject to the difficulties encountered in total iron analyses, since the presence of interfering materials in chemical analyses may be eliminated in making the radioactivity determinations.

The use of donor tagged red cells might be questioned since their introduction has been used to study the survival time of red cells in hosts. However, in the relatively iron-free anemic dog, when the red cells disintegrate due to age or trauma, the liberated tagged iron is very rapidly reincorporated into new cells without grossly affecting the level of the isotope in the red cells (*4*). The inconvenience of preparation of such donor animals may be obviated by feeding a single dose of tagged iron to the infested subject and allowing that part which is absorbed to be synthesized by the body into hemoglobin. This method would lend itself to studies of human hookworms, especially where it was inconvenient to prepare donors. It would only require in addition to the described method that one wait until the isotope had reached a constant value in the peripheral circulation, or about 10 days.

Counts were made of ova in these dog's feces on several occasions, but it was felt that the relative variability in the degree of hydration of the stools rendered it improbable that a reliable estimate of the true worm burden was made by using these counts.

However, if the extent of blood loss were followed, employing the method herein described, for a definite period of time, and a vermifuge were then administered and the recovered worms counted, one might determine

an average value for the amount of blood consumed per day per recovered worm. Thus:

Let R = total radioactivity in excreta.
C = concentration of radioactivity in red cells.
W = total worms.
D = total days.

$$L = \left(\frac{\text{Average loss of red cells}}{\text{worm}}\right)/\text{day}.$$

Then

$$L = \frac{R}{C\,W\,D}.$$

The fact that very little iron derived from red blood cell hemoglobin is normally excreted in feces would probably make it unnecessary to correct this formula by a determination of the base line fecal iron output after vermifugation.

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Prevention of Dietary Fatty Livers by Exposure to a Cold Environment[1]

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In studies of the lesions which develop due to a deficiency of the lipotropic factors, it has been shown on numerous occasions that the development of fatty livers or of hemorrhagic kidneys is closely linked to caloric intake and to metabolic requirements. Severe lesions are more easily produced when growth is rapid and when food intake is high. Inanition may protect the liver and kidneys of an animal subsisting on a deficient diet. In an environment one or two degrees above freezing, the caloric requirement is increased greatly, as indicated by increased oxygen consumption and increased food intake. When rats weighing more than 150 g are exposed to such an environment they usually survive and some growth occurs, but at a slower rate than normal.

Two groups of ten male rats (Wistar strain), bred locally and weighing from 170 to 200 g, were given a diet ad libitum which permitted good growth but was deficient in choline and its precursors. One group was exposed to a temperature of $2.5 \pm 1°$ C for a period of two weeks, while the other was maintained for the same period under similar conditions but at a temperature of $25 \pm 2°$ C. At the end of the two-week period the animals were sacrificed, and their livers were examined chemically and histologically.

As might be expected, the fat content of the livers of the control group was high, averaging $24.8 \pm 4.90\%$ (total lipid expressed as % of wet weight). The average value found in the group maintained at 2.5° C was $7.2 \pm 1.24\%$. The average weight of the livers was approximately the same, but the weights of dry fat-free residues of the livers of rats kept in the cold environment were significantly higher than those of the control group. Although rats in the cold room ate more (average 22 g/day) than the controls kept at room temperature (average 15 g/day), their increase in body weight was less (average 1.3 g/day) than that of the control group (average 3.5 g/day).

The prevention of excessive deposition of fat in the liver in spite of increased consumption of a severely hypolipotropic diet would seem to be associated with the greatly increased total metabolic rate. The results of further study of this finding may throw light on the mechanism of action of choline, and perhaps on intermediary metabolic pathways which may be affected by exposure to a cold environment.

[1] These experiments form part of a project supported by a grant from the Defence Research Board of Canada. We are indebted to Prof. C. H. Best for his continued interest, and to Drs. Jessie Ridout and Jean Patterson for the estimations of liver lipids.

Films from Hemicellulose Acetates[1]

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Up to the present time, cellulose has been the only plant polysaccharide which has been acetylated for the production of commercial films and fibers. Commercially, hemicelluloses are separated from their natural mixture with cellulose and are regarded as undesirable impurities in pulp destined for esterification. Yet the major proportion of the hemicellulose mixture present in plants consists of xylan, a linear polysaccharide which should produce strong films. Consequently, an investigation was undertaken to obtain further information on the film-forming characteristics of hemicellulose acetates.

The hemicelluloses are sometimes isolated from crude plant material by extraction with alkaline solutions. However, lignin interferes, not only because it retards complete solution of the hemicelluloses, but also because some of it dissolves in the extract, causing difficulty in purifying hemicelluloses. These disadvantages are avoided largely through selective removal of lignin with a maximum retention of unchanged polysaccharides. Such delignified pulps are termed holocellulose (*6*).

The corncob is a typical example of hemicellulose-rich material. Approximately 80% of the corncob consists of polysaccharide material, one-half of which is cellulose, whereas the remainder is made up of a mixture of hemicelluloses. The entire polysaccharide mixture or holocellulose can be prepared by a modification (*3*) of the

[1] Contribution by Department of Agricultural Chemistry, Purdue University Agricultural Experiment Station, Journal Paper No. 401.

usual sodium chlorite procedure (*5*). Practically all of the hemicelluloses may be removed from holocellulose by extraction with a 10% solution of NaOH. Analyses indicate that the residue is almost pure α-cellulose.

Neutralization of the alkaline hemicellulose solution causes precipitation of the higher molecular weight polysaccharides and leaves in solution most of the glycuronans and polysaccharides of comparatively low molecular weight. The precipitated material is called hemicellulose A. Most of the soluble material remaining in the neutral solution is precipitated by the addition of two volumes of alcohol and is called hemicellulose B (*2*).

Results in this laboratory show that practically all of hemicellulose A consists of xylan. The mixture contains only 3% of combined hexuronic acid anhydride. Hemicellulose A, 25% of the total holocellulose, can be esterified with acetic anhydride in the presence of 0.25% of nitric acid (*4*) to produce a white fibrous acetate containing 38.6% of acetyl groups (calculated for diacetyl xylan, 39.8%). The acetate is soluble in dioxane, pyridine, or in a chloroform-methanol 9:1 mixture. When the acetate is cast from any of these solvents, clear films are produced which show an average tensile strength of 7.2 kg/mm² when measured on a Scott IP-4 inclined-plane serigraph. Films from commercial cellulose triacetate, when prepared in a similar manner, have a tensile strength of 8.6 kg/mm². Films cast from solutions of mixtures of hemicellulose A acetate and cellulose triacetate are clear and strong provided that incorporation of hemicellulose A acetate does not exceed 50%. Larger amounts of hemicellulose A acetate produce cloudy films.

Hemicellulose B, 6% of which is glycuronan material, may be esterified easily by a mixture of acetic anhydride and pyridine, provided that it is first swelled in formamide (*1*). The resulting acetate is a light brown, powdery material having an acetyl content of 35.0%. When cast from a chloroform solution, it produces clear films having a tensile strength of 7.5 kg/mm². While films can be produced by mixing hemicellulose B acetate with either cellulose acetate or hemicellulose A acetate, they are all cloudy, indicating the immiscibility of hemicellulose B acetate with either of the other two acetates.

These results show that the presence of hemicellulose A acetates does not have an adverse effect on the production of clear films of high quality. It is only the hemicellulose B acetates and possibly other low molecular weight polysaccharides that are responsible for cloudy films. The hemicellulose B fraction is present in most plant tissues in small quantities only. It represents approximately 10% of corncob holocellulose. It may be easily and completely removed through short extraction with alkaline solutions of 1–2% concentration. The residue obtained from corncob holocellulose after such an extraction may be acetylated and cast into good films.

These observations suggest the desirability of revising pulping techniques in order to retain more of the higher molecular weight hemicellulose fraction and thereby permit the use of these hemicelluloses, which are now discarded in commercial practice.

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A Possible Explanation of Symptom Formation in Tobacco with Frenching and Mineral Deficiencies

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Studies with Maryland Medium Broadleaf tobacco seedlings in aseptic culture (*3*, *4*) have disclosed that slight excesses of amino acids in the medium led to the formation of characteristic growth abnormalities and chloroses. The symptoms of toxicity covered a wide range but were specific for each amino acid. Admixtures in some cases led to appearance of new abnormalities. Most effective was L(−)-hydroxyproline (3 ppm), the seedlings being killed at 5 ppm. A close approximation of the extreme symptoms of frenching was produced with the natural amino acid, L(+)-isoleucine (100 ppm); the unnatural isomer being relatively ineffective. These growth abnormalities included inhibition of stem and branch elongation, accelerated development of the leaves in the axillary buds, and reticular chlorosis of newly expanded leaves, together with greatly reduced leaf laminae ("strap leaves"). Increased leaf number was a prominent feature.

Similar responses to amino acids have now been obtained with tobacco plants growing in water-culture and soil. Frenching of oriental Xanthi tobacco was obtained with DL-isoleucine at 20 ppm in water-culture. Partially sterilized soil required very large quantities, however, in order to produce the symptoms of frenching in Connecticut Broadleaf and Xanthi tobacco.

Large scale analytical studies with field plants of Maryland Medium Broadleaf tobacco have afforded some confirmation of the interpretation that excessive accumulation of free amino acids in the plant may be a primary cause of symptom formation in certain abnormalities. Free amino acids in leaf laminae of mildly frenched plants increased to a maximum of 121% above normal. J. L. Stokes of Merck and Company estimated the corresponding increase for L(+)-isoleucine to be 50%. Free amino acids in leaf laminae of plants showing symptoms of mineral deficiencies increased with nitrogen deficiency by 32%; phosphorus, 48%; potassium, 587%; calcium, 120%; magnesium, 283%; and boron, 27%. These values are maxima. They confirm and extend the

data of mineral deficiency studies with green plants (*1*, *2*).

The increases in free amino acids are considered to be evidence that these chemical elements participate in protein metabolism, and that formation of symptoms is primarily due to the localized action of excessively accumulated normal metabolites. Growth responses and chloroses with amino acids are of sufficient variety to include many of the individual symptoms comprising the syndromes displayed with mineral deficiencies. Except possibly for magnesium, breakdown of chlorophyll in mineral deficiency is, therefore, not necessarily indicative of mineral participation in chlorophyll formation, as has often been assumed. The probable participation of the chemical elements in the enzymes regulating protein metabolism warrants the exercise of caution in associating specific mineral deficiencies with physiological processes in the plant. Drastic interference in the basic function of the plant should cause a breakdown in all physiological processes at varying rates.

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Annual Variation in Nicotine Content of Tobacco

Earl W. Flosdorf and Arthur W. Palmer

Bayuk Cigars Inc., Philadelphia

In connection with the change in nicotine content during fermentation of cigar leaf tobacco of the Pennsylvania Seedleaf variety, Frankenburg (*1*) has given data for crops of four different years. This percentage is given before and after "sweat" by the manufacturer, which is usually referred to as "final forced fermentation." In addition to reduction in nicotine content during this stage, there is a reduction in the curing by the farmer before the manufacturer purchases the tobacco. Then there is reduction during storage fermentation by the manufacturer before the tobacco is put into final forced fermentation. In our laboratory, tobacco, as received by the manfacturer from the farmer after shed-curing, has been analyzed for alkaloids routinely for a period of more than 20 years. Table 1 shows the variation from year to year over that period.

The data in the table for the years 1936, 1938, 1939, and 1941 are somewhat higher than those reported by Frankenburg for the same years. This is to be expected, inasmuch as the data were obtained with tobaccos as received from the farmers, so there was no loss from any processing by the manufacturer.

The results include nor-nicotine and other alkaloids which are present in trace amounts and for that reason the percentage is reported as total alkaloids. Each year's crop represents an average of tobaccos grown by about 100 different farmers. Five leaves were taken from each of three hands distributed throughout one bundle from each farmer's tobacco. The leaves from

TABLE 1

ALKALOIDS IN TOBACCO AFTER CURING

Crop	Total alkaloids (oven-dried basis)	pH
	%	
1927	3.1	..
1928	2.8	..
1929	4.6	..
1930	6.0	5.8
1931	3.3	6.9
1932	5.0	5.2
1933	2.5	5.8
1934	3.0	7.3
1935	4.5	6.5
1936	4.3	6.4
1938	3.1	..
1939	3.0	..
1940	3.2	6.2
1941	4.1	5.4
1942	3.1	6.7
1943	5.0	6.2
1944	3.6	6.5
1945	2.8	6.8
1946	2.9	6.5
1947	4.2	6.3
1948	3.15	6.5

all these locations were ground and mixed to produce a uniform sample. By quartering, a final representative sample was obtained for analysis.

In addition to the representative sample for each year's crop, individual farmers' tobaccos have been analyzed. It has been found that from farmer to farmer there is variation in any given year, with some tobaccos having as little as half of the average for the year and others as much as 50% more. However, normally over 90% of the individual farmers' tobaccos do not vary more than about ±10% from the average for the year. This uniformity is to be expected, inasmuch as the tobacco represents only that grown in the general vicinity of Lancaster, Pennsylvania. Where variations do occur, they represent differences from field to field, depending upon the soil, fertilizer, seed, and variations in rainfall occurring between the time of early and late harvesting of crops by different farmers. There is no relation between pH and alkaloid content.

Plotting the average alkaloid content for the various years against the amount of rainfall during the growing season shows a definite trend of higher alkaloid content in tobaccos grown in dry seasons. By breaking this down into months, it is found that the influence of rainfall on the alkaloid content is somewhat greater towards the end of the growing season, as the time of harvest approaches.

As a further point of interest, individual crops have been followed through complete manufacturing operations, including all fermentation. The average amount of alkaloid reduction is about 40%, all based on oven-dried samples. In certain extreme conditions, this may be as little as 20%, or as much as 80% reduction. This

amount of reduction may be controlled and generally it is kept close to the average percentage mentioned.

Reference

1. FRANKENBURG, W. G. *Science*, 1948, **107**, 427.

Simplified Preparative Electrophoresis at Room Temperature[1]

Harold A. Abramson[2]

Biological Laboratory,
Cold Spring Harbor, New York

Many attempts have been made to adapt the separation of electrically charged ions like proteins to simple equipment operable at room temperature. Membranes, sand barriers, gels, and jellies have been used to immobilize the material and thus prevent convection from mixing the protein in a solution, P, with the adjacent buffer solution, B. Tiselius (*1*) points out that aside from optical observations his method increases the potential gradient in the **U**-tube without undesirable heat convection, simplifies sampling, and avoids disturbing electrolytic processes.

The equipment for the preparative method described here costs less than $50. It suitably embodies the advantages of the Tiselius method just mentioned, and is especially adaptable for use at room temperature without any temperature control. The technique employs a modification of the classical **U**-tube with large side vessels for electrodes (carbons or reversible electrodes). Tail-hole stopcocks are used for withdrawing samples at the side, or a two-way stopcock at the bottom of the **U**-tube is employed for forming the boundary and draining the electrophoretically purified fractions from either side of the **U**-tube. The method depends upon controlling solutions B and P so that they will have different densities, viscosities, pH's, and conductances as follows: solution B (supernatant) will have a high coefficient of viscosity at the pH of the isoelectric point of the protein contained in solution P, to be immobilized in the lower part of the **U**-tube; solution B will have a density considerably less than solution P, so that as the boundary P-B is formed, a well-defined boundary, stable enough for preparative electrophoresis results. Typical solutions used by the writer and his co-workers (*2*) for the past year for the separation of trifidin and artefolin (*1*), the unpigmented fractions of giant and dwarf ragweed extracts, have been: B = 40% glycerol at pH 6.8; P = 50% glycerol extract of ragweed pollen. The electrical conductance of solutions B and P in the separation should be regulated so that as little electrolyte as convenient is in P, with a suitable amount in B, to control the pH and drop in potential at the beginning of the separation. For example, in the case of ragweed extracts, no saline was added to the ragweed to be fractionated in solution P. The 40% glycerol in B contained M/15 phosphate buffer at pH 6.8. Thus initially the main drop in potential was across the material to be separated and fractionation was facilitated. A striking experiment demonstrating this technique may be made by having solution B at about pH 6.8 employing M/15 phosphate buffer in 40% glycerine, with solution P, a mixture of hemoglobin and T-1824 (a negatively charged dye), in 50% glycerine. At this pH, the isoelectric point of hemoglobin is electrophoretically fixed at the boundaries, whereas the dye T-1824 migrates out of the mixture to the anode, leaving the hemoglobin with a fairly sharp boundary at the negative side after 24 hr.

It may be emphasized that our method utilizes Newtonian or truly viscous liquids. The convection ordinarily resulting from the application of 450 volts to a **U**-tube, 60 cm long with an internal diameter of 1.0 cm, at room temperature is avoided by the use of only high viscosities, not plasticities. No membranes, jellies, or similar mechanical devices are required. The temperature in the laboratories at Cold Spring Harbor during the summer of 1948 varied considerably over 24 hr but did not disturb the boundaries for preparative purposes during 4-day electrophoretic separations. The apparatus can be readily used in an ice chest. If room temperature does not destroy the material to be studied, it is preferable not only because of simplicity but also because the mobilities are greater at this temperature.

TABLE 1

COMPARISON OF FORMATION OF CLASSICAL TISSUES BOUNDARIES AND THOSE OF THE MODIFIED TECHNIQUE

Tiselius method	Method reported herein
Conductance B* = conductance P†	Conductance B >> conductance P
Viscosity B = viscosity P	Viscosity B < viscosity P
Density B = or slightly less than P	Density B < density P
pH of B = pH of P	The pH of B at or close to isoelectric point of protein to be separated in solution P
Temperature controlled at or near 4° C	Room temperature fluctuations—no temperature control

* Supernatant solution.
† Lower protein solution. Note that both P and B have Newtonian flow.

Table 1 summarizes the differences in preparative procedures with the classical method of Tiselius and the method herein described.

The fractionation experiments based upon this technique will soon be reported in detail (*2*). The early experiments were done with C. Reiter and M. Loebl.

[1] Aided in part by a grant from Josiah Macy Jr. Foundation.
[2] Present address: 133 East 58th Street, New York City.

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2. ABRAMSON, H. A. *et al.* To be published.
3. TISELIUS, A. XI International Congress of Pure and Applied Chemistry. London. *Supplement to chemistry and industry*, 1948, p. 9.

Comments and Communications

Natural Vegetation in the Willamette Valley

The letter from J. E. Smith on "Natural Vegetation in the Willamette Valley, Oregon" (*Science*, 1949, **109**, 42) clearly points out the need for historical records in ecological studies. In the Nisqually River drainage area south of the city of Tacoma, Washington, the vegetation type map shows extensive areas of young Douglas fir forest. Much of this originally was prairie grassland, according to records of the early settlers. In less than a century the prairies have changed to forest, after rather heavy grazing by domestic livestock. Previously the prairie was only lightly grazed by game animals, and occasional flash fires kept the brush and conifers out.

To the southwest, below Tenino, lies the section of this old prairie country in which the Mima mounds thickly dot the landscape. Numerous interesting theories to account for their formation have been put forth. They have been attributed to eddy currents at the time the area was submerged beneath Puget Sound, to surface erosion under peculiar conditions, to the work of Indian tribes, to ant hills, to glacial action, etc. Victor B. Scheffer, in "The Mystery of the Mima Mounds" (*The Scientific Monthly*, 1947, **65**, 283), proposes the theory that they were built by families or colonies of pocket gophers. While his evidence is indirect, he makes a reasonable development. Proponents of the glacier action source hold that no gopher ever carried big stones uphill, and point to the presence of rounded stones and boulders in the upper parts of the mounds. And so it goes. Here a geologically long historical record is needed to settle the matter.

Sometimes reconstructions from fossil records tell the story. R. W. Chaney brings this out very nicely in *Ancient forests of Oregon: A study of earth history in Western America*. Recent ecological studies by other scientists show the present stage of vegetation; the paleobotanical studies demonstrate its development. Ecology, to explain its present findings properly, generally must depend on indisputable interpretation of related evidence from the past.

Portland, Oregon W. E. BULLARD

Thermal Coefficient of the Refractive Index of Water

A recent technical paper by Antonoff and Conan (*Science*, 1949, **109**, 255) reports a discontinuity in the thermal expansion coefficient of water near 50.5° C. We have been measuring, by a direct method (Hawkes, J. B. and Astheimer, R. W., *J. Opt. Soc. Amer.*, 1948, **38**, 617), the thermal coefficient of the index of refraction of water up to 53° C. Continuous observation (i.e. fringe counting) is inherent in the method, so that we have left no unobserved points in this neighborhood.

The well-known relation between refractive index and density,

$$P = \frac{1}{d}\left[\frac{n^2-1}{n^2+2}\right],$$

can be used to interpret the results for the density, found by Antonoff and Conan, in terms of the thermal coefficient of the index, which we have measured. Results are given in Table 1, with P (above) as 0.20616 cgs units.

TABLE 1

T (°C)	Estimated from Antonoff & Conan		Observed
	$\frac{d(d)}{dT} \times 10^4$	$\frac{dn}{dT} \times 10^4$	$\frac{dn}{dT} \times 10^4$
49	−4.9	−1.80	−1.64
50	−5.7	−2.09	−1.66
	−6.0	−2.20	
50.5			−1.67
	−3.0	−1.10	
51	−3.6	−1.32	−1.68
52	−4.4	−1.61	−1.70

These values are plotted in Fig. 1. The Antonoff and Conan values are estimated from their published curve; those of Hawkes and Astheimer by observations.

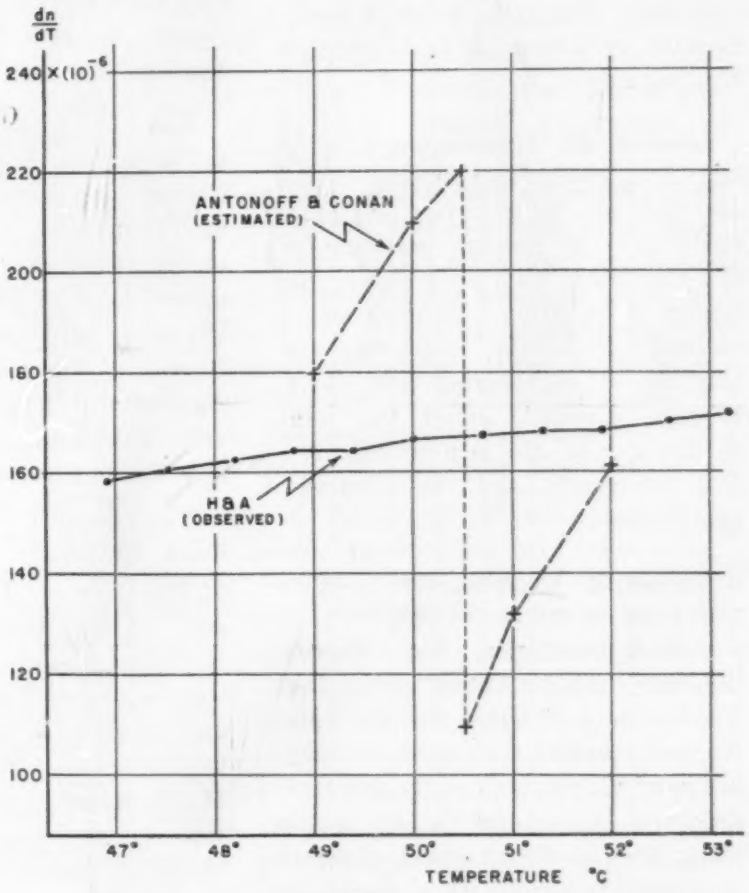

FIG. 1.

If the density of water does behave with temperature as reported by Antonoff and Conan, and if our results on the thermal coefficient of the refractive index are correct, there must be a precisely compensating discontinuity in the value of the Lorentz constant, P, at 50.5° C.

JOHN B. HAWKES and ROBERT W. ASTHEIMER

Stevens Institute of Technology,
Hoboken, New Jersey

NEWS and Notes

Edward C. Creutz, head of the Physics Department at Carnegie Institute of Technology, has been appointed director of the Carnegie Nuclear Research Center at Saxonburg, Pennsylvania. The recently established center houses the institute's 400-Mev synchrocyclotron, which is expected to go into operation next spring.

George B. Cressey, of Syracuse University's Department of Geography, is visiting Latin America on behalf of the International Geographical Union, of which he is president. He will return by mid-February. The trip, which is partly financed by Unesco, is taking him to 13 countries.

Lincoln R. Thiesmeyer has resigned as executive assistant to the director of Brookhaven National Laboratory to become president of the Canadian Pulp and Paper Research Corporation. A program to intensify scientific research and training in engineering and chemistry is planned, under the joint sponsorship of the corporation, McGill University, and the Dominion government.

Ernest R. Kaswell, associate director of research at Fabric Research Laboratories, Inc., Boston, has been elected a Fellow of the Textile Institute of Great Britain. Mr. Kaswell received the award in recognition of his research in the low temperature characteristics of textile materials and the stripping of colors from wool to permit its re-use.

H. E. King, formerly senior research scientist at the New York State Psychiatric Institute, and **Kathleen M. Young,** formerly psychologist for the Children's Group, Rockland State Hospital, New York, have both received appointments as assistant professor of psychiatry at the Tulane University School of Medicine and as visiting scientist at the Charity Hospital of Louisiana. Dr. King will conduct research in psychopathology and human brain function; Dr. Young will be in charge of all clinical psychological services of the Tulane Psychiatric Clinic.

Helen Dodson has been appointed associate professor of astronomy at the University of Michigan, effective July 1. At that time she will conclude her present part-time appointment with Goucher College at Baltimore and devote full time to the solar research she has been doing at the McMath Hulbert Observatory at Lake Angelus.

Carl L. Larson, assistant chief of the Laboratory of Infectious Diseases, National Institutes of Health, Bethesda, Maryland, has been appointed head of the Rocky Mountain Laboratory, Hamilton, Montana. Dr. Larson succeeds the late **Ralph R. Parker.**

Roy L. Lovvorn, professor of agronomy at North Carolina State College, and agent, Division of Forage Crops and Diseases, U. S. Department of Agriculture, has been named head of the recently created Division of Weed Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, at Beltsville, Maryland. He will assume his new duties January 16.

Two new staff appointments in the State University of Iowa's College of Medicine are **James W. Culbertson,** of the Boston University of Medicine, who has been appointed assistant professor of internal medicine and director of the Laboratory for Cardiovascular Research, and **Paul M. Seebohm,** who will be an associate in the Department of Internal Medicine and will also direct the Allergy Clinic at the university hospitals.

Nicholas E. Golovin has been appointed assistant to the director of the National Bureau of Standards. Prior to joining the bureau in April of this year, Mr. Golovin headed the Management Division on the Staff of the Commander, Naval Ordnance Test Station, Inyokern, California.

Visitors to U. S.

G. E. André and **C. C. Tavernier,** of the Union Minière, Brussels, Belgium; **Peter Baertschi,** of the Institute of Physical Chemistry, University of Basel, Switzerland, who is at present at the University of Chicago; **André Giraud,** chemical engineer, Direction des Carburants, Paris; **Hans G. Lind,** head of the Testing Laboratory, Aktiebolaget Nyborgs Yllefabrik, Norrkoping, Sweden; and **Olle Svensson,** honorary fellow of the American-Scandinavian Foundation, and representing the AB Bofors Nobelkrut, Bofors, Sweden, recently visited the National Bureau of Standards.

Leone Lattes, chairman of the Department of Medical Jurisprudence at the University of Pavia, Italy, will present four lectures on legal medicine in Chicago December 5, 7, 8, and 10. The first three will be held at the Chicago Medical School, the fourth at Mount Sinai Hospital. All lectures will begin at 12: 30 p.m.

Grants and Awards

Grants-in-aid totaling $100,000 for unrestricted use in fundamental chemical research have been authorized for the second year by the DuPont Company. Institutions to receive $10,000 each for 1950–51 are California Institute of Technology, Cornell University, Harvard University, Massachusetts Institute of Technology, Ohio State University, Princeton University, Yale University, University of Illinois, University of Minnesota, and the University of Wisconsin. All of the schools received similar awards from the company last year when the plan was inaugurated on a trial basis with the aim of increasing fundamental research in this country.

Sharp and Dohme, Inc., of Philadelphia, has awarded research grants to Samuel L. Meyer and Lowell F. Bailey, of the Department of Botany, University of Tennessee, and H. Brieger, of Jefferson Medical College, Philadelphia. The grant to Dr. Meyer and Prof. Bailey is in support of their investigation on antiseptics.

Dr. Brieger's grant is for clinical studies on tetraethylthiuram disulfide.

The Rumford Medal of the American Academy of Arts and Sciences was presented to Ira S. Bowen, director of the Mt. Wilson and Palomar Observatories. Dr. Bowen received the medal for his work in spectroscopy, and particularly for his explanation of the spectral lines of nebulium.

The first Harold DeWitt Smith Memorial Medal will be presented to Herbert F. Schiefer, of the National Bureau of Standards' textile laboratory, at the spring meeting of the American Society for Testing Materials. Dr. Schiefer will receive the award in recognition of his work in the utilization of textile fibers.

The DuPont Company, of Wilmington, Delaware, has announced the award of 76 postgraduate and postdoctoral fellowships, amounting to $224,000, to 47 universities for the 1950–51 academic year. Of the 70 postgraduate fellowships, 45 are in chemistry, 15 in chemical engineering, 5 in mechanical engineering, 3 in physics, and 2 in metallurgy. The 6 postdoctoral fellowships are for work in chemistry.

The Medical Library Association scholarships for 1949–50 have been granted to three foreign medical librarians. The recipients are *Erica Emma Johannsen Oehrens*, assistant librarian at United Nations Economic Commission for Latin America, Santiago, Chile; *Ileana Ines Johannsen Oehrens*, assistant in the School of Health Library, University of Chile; and *Juan Carlos Secondi*, medical student and a graduate of the Library School, University of Montevideo.

Fellowships

A graduate fellowship in geophysical engineering has been established at the Colorado School of Mines by the Standard Oil Company of Texas. The fellowship provides $1,250 a year plus an additional amount for expenses incident to the program of study. It has as its objective the encouragement of graduate study in the field of petroleum exploration by geophysics.

Armour Research Foundation of Illinois Institute of Technology will offer industrial research fellowships in physics, chemistry, metallurgy, ceramics, mechanics, and electrical engineering for a 21-month period beginning in September, 1950. Awards will be made to graduates under 28 years of age who hold a B.A. from an accredited engineering or scientific school or from a liberal arts college with a major in science. Fellows will receive, in addition to full tuition, a monthly stipend of $150 during the first academic year, $275 during the summer, and $175 during the second academic year. Application forms may be obtained from the Dean of the Graduate School, Illinois Institute of Technology, and should be submitted by *March 15*.

Ten research fellowships in the fields of medicine, dentistry, and pharmacy will be awarded by the University of Illinois Graduate College, Chicago. In addition to tuition, the fellowships carry stipends of $1,800 per year for medical and dental graduates and $1,200 for pharmacy graduates. Application blanks may be obtained from the Assistant Dean, The Graduate College, University of Illinois, 808 South Wood Street, Chicago 12.

A research fellowship for the study of triglyceride fats and oils has been established at the **University of Pittsburgh** by Armour and Company. It will provide an allotment of $2,500 yearly for a period of three years. The fellowship, which will be used by a graduate student to be selected later, is under the direction of Bernard F. Daubert, research professor and administrator in the university's Chemistry Department.

The Illinois Institute of Technology is accepting applications for the 1950 Westinghouse Fellowship in power systems engineering, consisting of $1,500 and tuition for three semesters of full-time training leading to an M.S. degree in electrical engineering. Candidates must have a bachelor's degree in electrical engineering from an accredited engineering college. Term of fellowship will begin September, 1950. Applications must be received by *March 15*. The winner will be announced April 1. Further information and application blanks may be obtained from the Dean of the Graduate School, Illinois Institute of Technology, Chicago 16.

Colleges and Universities

The Arctic Institute of North America has established an office at **The Johns Hopkins University** which will coordinate the institute's existing arctic research projects and originate new ones. This is the second arctic research project to become associated with Johns Hopkins (see *Science*, December 9, page 647).

M. C. Shelesnyak will head the office, with headquarters in the Isaiah Bowman School of Geography. He was one of the original fellows of the institute and more recently was head of the Ecology Branch of the Office of Naval Research. He has also been appointed lecturer in ecology at Johns Hopkins.

The institute staff will work closely with the Bowman School of Geography, the Walter Hines Page School of International Relations, and other related scientific departments at Johns Hopkins. Other institute offices are at McGill University in Montreal and at the American Geographical Society in New York City.

A course in International Economic Cooperation has been established at **New York University** through a gift of $5,000 donated by the Netherlands American Foundation and the Belgian American Educational Foundation, Inc. Dr. Jan Goris, Commissioner of Information for Belgium in the U. S., will direct the new course. It is entitled "Experiments in International Economic Cooperation with Special Reference to the Benelux," and will be a two-year course.

Industrial Laboratories

Lever Brothers Company, New York City, recently announced three new appointments: *Marvin J. Hall*, director of the central laboratories of the Kraft Foods Company, as

associate director of research; *Cheves T. Walling*, former member of the staff of the general laboratories of the U. S. Rubber Company, as chief supervisor of organic research; and *Leonard J. Vinson*, supervisor of research on biochemical problems at the Armour Research Foundation, Chicago, as chief supervisor of biological research in Lever's Basic Laboratories Division. Until the completion of the company's new research center at Edgewater, New Jersey, the new members of the staff will be located at the present headquarters in Cambridge, Massachusetts.

Cuthbert C. Hurd, former research head at Oak Ridge, Tennessee, has been named director of the Applied Science Department at **International Business Machines Corporation,** New York City. At Oak Ridge, Dr. Hurd was also chairman of a committee on technical calculation procedures at the Gaseous Diffusion Plant.

A gift of $30,000, to be used for the establishment of a pharmacy, has been presented by the **A. H. Robins Company** to the Richmond Memorial Hospital fund. The 321-bed hospital, which will be located in a part of Richmond not now served by a hospital, was proposed as the result of a survey of the city's hospital needs conducted by Robin C. Buerki, of the University of Pennsylvania.

Meetings and Elections

Industrial and Safety Problems of Nuclear Technology will be the subject of a three-day conference beginning January 10, to be held by New York University in cooperation with the U. S. Atomic Energy Commission. The purpose of the conference, which will take place at the General Electric Auditorium, New York City, is to encourage a wider and safer use of radioactive materials. It is sponsored by the Division of General Elucation and the Center for Safety Education of New York University.

The National Speleological Society will meet January 14 at the Philadelphia Academy of Natural Sciences, Philadelphia. Inquiries should be addressed to Mrs. Ellen Moffett, Secretary, 2702 Wisconsin Avenue, N.W., Washington, D. C. Dates for the first international congress of speleological societies have been set for May 27–30. The congress will be in Monterrey, Mexico.

The Division of High Polymer Physics of the American Physical Society will hold its 7th meeting in New York City, February 2–4. Most sessions will take place at the Polytechnic Institute of Brooklyn. A feature of the meeting is a symposium on stress phenomena from the viewpoint of solid state and high polymer physics, to be presented at Columbia University on February 3.

U. S. scientists who have been invited to attend the symposium **"La Structure et la Physiologie des Sociétés Animales,"** to be held in Paris March 19–25, are W. C. Allee, Department of Zoology, University of Chicago; C. R. Carpenter, Department of Psychology, Pennsylvania State College; A. E. Emerson, Department of Zoology, University of Chicago; and T. G. Schneirla, American Museum of Natural History, New York City.

Officers elected for 1950 at a three-society meeting in Memphis, Tennessee, last month are: **American Society of Tropical Medicine:** president elect, Paul F. Russell, Rockefeller Foundation, New York City; vice president, F. J. Brady, U. S. Public Health Service, Bethesda, Maryland; and secretary-treasurer, Quentin Geiman, Harvard University, Boston. **American Academy of Tropical Medicine:** president, E. C. Faust, Tulane University, New Orleans; vice president, Fred L. Soper, Pan American Sanitary Bureau, Washington, D. C.; Clay G. Huff, Naval Medical Research Institute, USN Medical Center, Bethesda; treasurer, H. E. Meleney, New York University School of Medicine. **National Malaria Society:** president, Paul F. Russell, Rockefeller Foundation; president elect, Justin M. Andrews, U. S. Public Health Service, Atlanta, Georgia; vice president, W. H. W. Komp, U. S. Public Health Service, Bethesda, Maryland; secretary-treasurer, Martin D. Young, U. S. Public Health Service, Columbia, South Carolina.

The Society of American Foresters has elected Charles F. Evans, assistant regional forester for the southern region of the U. S. Forest Service, to serve as president for the two-year term 1950–51. He succeeds Clyde S. Martin, of Tacoma, Washington. Clarence S. Herr, resident woods manager of the Brown Company, Berlin, New Hampshire, was elected vice president.

Deaths

William J. Bonisteel, botanist, died December 12 in Mexico City of a cerebral hemorrhage. He was 57 years old. Dr. Bonisteel was research director of Cia Minera Sta, Lucia, S. A., Mexico, and had been doing research in plant breeding and rare earth minerals in Mexico.

John Stanley Coulter, chairman of the Department of Physical Medicine at Northwest University Medical School, died at his home in Westville, Indiana at the age of 64. Dr. Coulter was an authority on rehabilitation and in 1943 received the Gold Key Award of the American Congress of Physical Medicine.

Atomic Energy Commission laboratories issued 57 declassified and unclassified reports last month in the fields of biology and medicine, chemistry, engineering, mineralogy, metallurgy and ceramics, and physics. Subjects reported on include the effect of low dosages of radiation upon blood counts of individuals exposed to ionizing radiation; a leak detection method in industrial chemical processing systems, originally developed at the University of California's Radiation Laboratory in 1943; a low cost production method for industrial fluorine; and the latest results in the measurement of the heat of vaporization and vapor pressure of graphite. A complete list of the reports and information on how to get any of them may be obtained from the Document Sales Agency, Atomic Energy Commission, Box E, Oak Ridge, Tennessee.

SCIENCE

DECEMBER 30, 1949

GOVERNMENT SUPPORT OF RESEARCH

ALAN T. WATERMAN

TECHNICAL PAPERS

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NEWS AND NOTES

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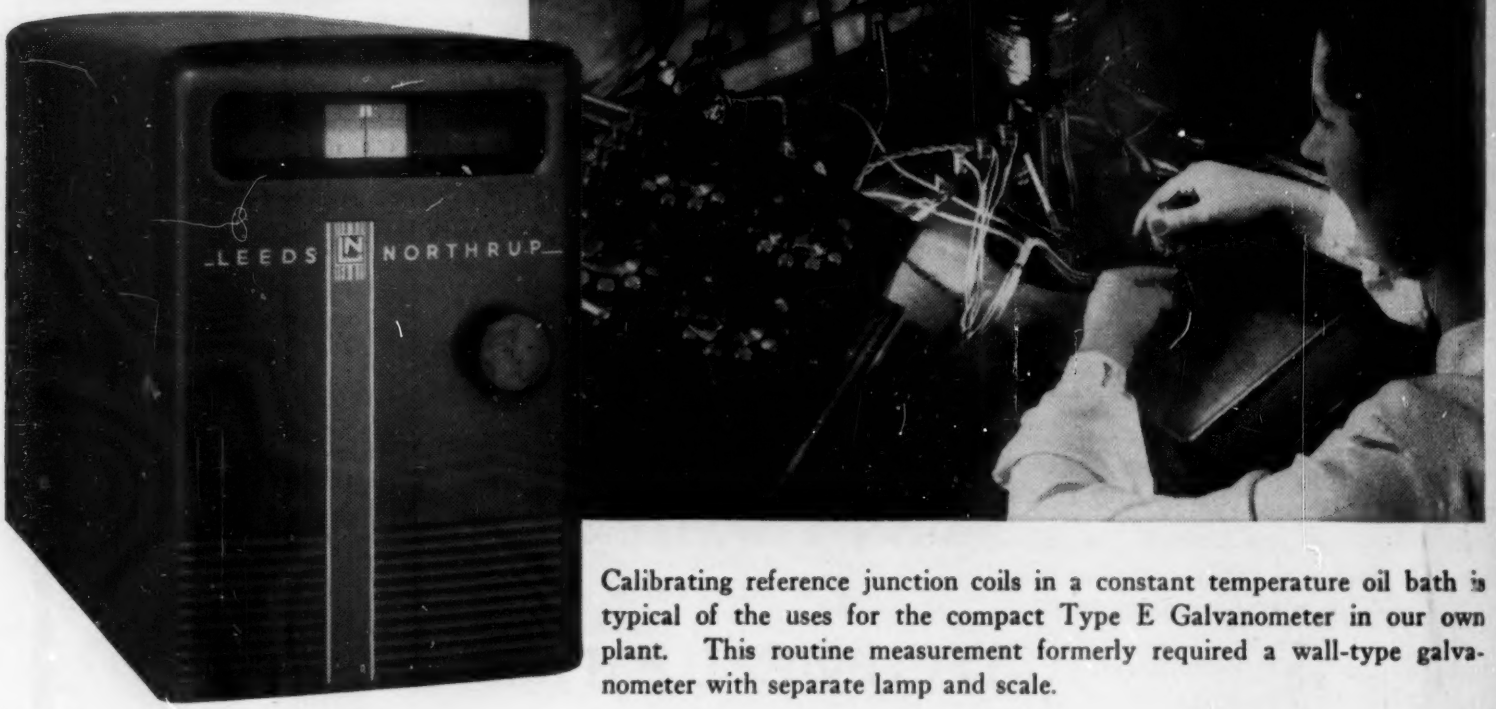
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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2. Spots show brightly on recessed scale. No scale-shade is required . . . even in a well-lighted room;
3. Zero is adjusted simply by turning the knob near the scale;
4. Unique two-spot design virtually eliminates "spot-chasing". The larger primary spot moves with full sensitivity. The smaller—but brighter—spot, "geared down" to a fraction of this sensitivity, moves so slowly that the user can see direction of unbalance; hence restores balance without hunting.

Type E sensitivity per mm. can be 0.5 microvolt (total circuit resistance 67 ohms); 0.005 or 0.0005 microampere—with periods of 3.0, 2.5, and 3.0 seconds respectively. The moving systems necessary to change sensitivity are interchangeable. Thus, a *single* Type E, with two additional systems, gives the same variety of characteristics as *three* complete galvanometers.

Catalog ED Sec. 1 sent on request. Write Leeds & Northrup Company, 4926 Stenton Ave., Philadelphia 44, Penna.

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